B1

1

Real-Time Measurement of Radionuclides in Soil

Superfund National Radiation Meeting
February 8, 2006

Carl Spreng
Colorado Dept. of Public Health & Environment
Interstate Technology & Regulatory Council

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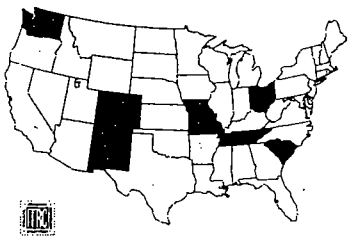
"Issues of Long-Term Stewardship: State Regulators' Perspectives"



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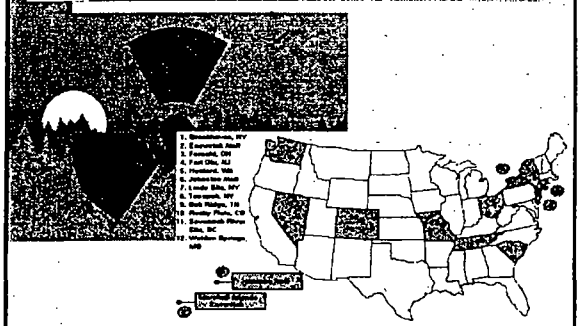
"Determining Cleanup Goals at Radioactively-Contaminated Sites"



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Internet-Based Training

"Radiation Risk/Dose Assessment: Updates and Tools"
(next: August 2006)

"Radiation Site Cleanup: CERCLA Requirements and Guidance"
(next: February 23, 2006)

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"Real-Time Measurement of Radionuclides in Soil"

"Use of Real-*Time Instrumentation to Achieve Site Closure*"

Paula Kirk
Bechtel Jacobs Company, LLC

Dale Pflug, Bob Johnson, David Miller
Argonne National Laboratory

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MARSSIM – The Closure Process

Multi-Agency Radiation Survey and Site Investigation Manual

1) *Standardized and consistent approach for radiological surveys*
2) *Final status surveys: demonstrate compliance with cleanup regulations*
3) *Technically defensible process for demonstrating closure*

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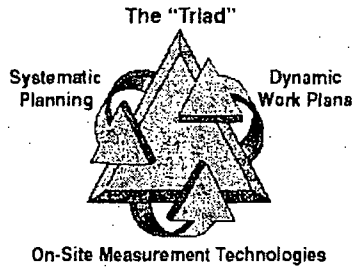
The Triad Process



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The Triad Process

1 - Systematic Project Planning

- Managing uncertainty to reach project goals
- Development and use of conceptual site models

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The Triad Process

2 - Dynamic Work Plan Strategies

- Allows modification of the work plan as data is collected and analyzed
- Specifies the logic to be used in data collection and remediation

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The Triad Process

3 - Use of On-Site (Real-Time) Data

- Timely information to make modifications to the work plan
- Data available quickly enough to have an impact on the course of work

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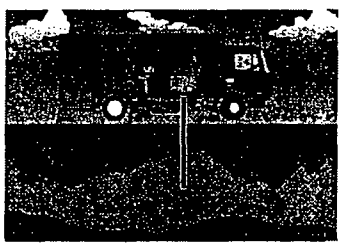
Technical and Regulatory Guidance for the Triad Approach: A New Paradigm for Environmental Project Management



December 2003

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Compatibility between MARSSIM, Triad, and CERCLA

Each process:

- employs survey planning driven by clear identification of project objectives,
- implements the plan,
- makes decisions based on the analysis of the survey data.

Measurement Technologies for Radiological Contaminants

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- **Surface Measurement Technologies**
- **Mobile and Stationary Platforms**
- **Subsurface Measurement Technologies**

Radiation Detectors:

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1. Scintillation
2. Solid-state
3. Gas-filled
   (ionization, proportional, Geiger-Mueller)
4. Passive Integrating Detectors

Radiation Detectors:

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- Scintillation → **Sodium Iodide**
- Solid-state → **High-*Purity Ge***
- Gas-filled
  (ionization, proportional, Geiger-Mueller)
- Passive Integrating Detectors

Sodium Iodide (NaI) Detectors

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- Scintillation detector (crystal) emits light
- Frequency of emitted light is shifted to a detectable range by an activator (Tl)
- Coupled with a photomultiplier (light → electrical charges)
- Intensity of electrical pulses measured by an MCA (multi-channel pulse height analyzer)
- Output → computer → gamma ray spectrum **or** total gross count
- FIDLER – thin crystal detects low-energy gamma rays at high efficiency

High Purity Germanium Detector (HPGe)

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- Semiconductor type of detector
- Higher resolution than NaI detector (2 KeV *vs.* 50 KeV)
- High quality stationary measurements
- Delineation of "hot spots"
- Susceptible to thermal signal degradation; electronics must be cooled

Tripod-mounted HPGe detector

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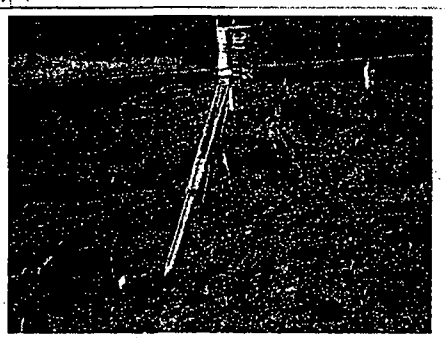

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Location Control and Mapping Technologies

+Global Positioning Systems
+Civil Survey-Grade Systems
+Laser-Based Tracking Systems
+Laser Broadcast Systems

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CASE STUDY SITES

- Ashland 2 FUSRAP Site, NY
- Brookhaven National Laboratory, NY
- East Tennessee Technology Park, TN
- Fernald Environmental Management Project, OH
- Idaho National Laboratory, ID
- Kirkland Air Force Base, NM
- Mt. Pleasant NORM Site, MI
- Nevada Test Site, NV
- Paducah Gaseous Diffusion Plant, KY
- Rocky Flats, CO
- Savannah River Site, SC

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Integrated Technology Suite (ITS)

- Real-time field analytical information system that combines:
  1) gamma-ray spectrometry (NaI + HPGe),
  2) global positioning system, and
  3) geographic information system
- Used at Fernald and Oak Ridge (ETTP)

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Integrated Technology Suite (ITS)

- Tripod mounted HPGe enables differentiation between isotopes (U238 and U235) and gives more accurate readings
- Integrated with RSS mapping and data analysis software to enable real time measurements (software developed by INL)
- Color-coded maps of radionuclide concentrations in surface and near-surface soils

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ITS Platforms:

- Several platforms suited to different terrains:
  - R-TRAK
  - Gator
  - RSS (Radiological Scanning System)
  - EMS (Excavator Mounted System)

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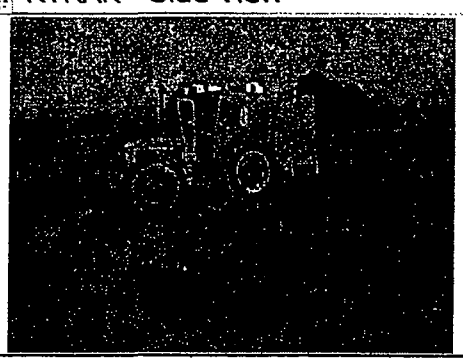
RTRAK - Side View



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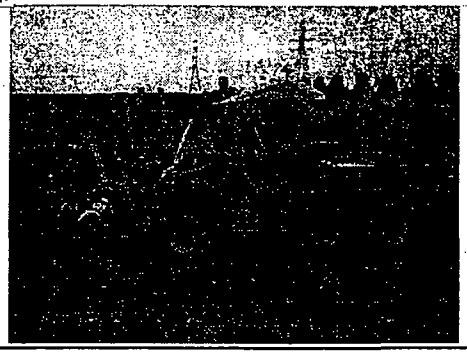
Gator - Side View



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Radiological Scanning System (RSS)

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Excavator Mounted System (EMS) in Contamination Area

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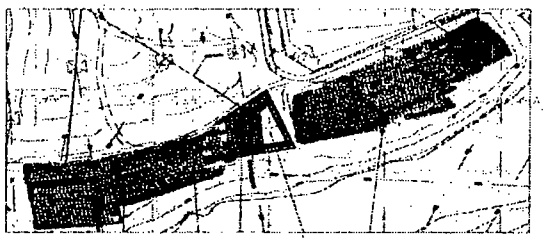
ITS Map From K-901 Area



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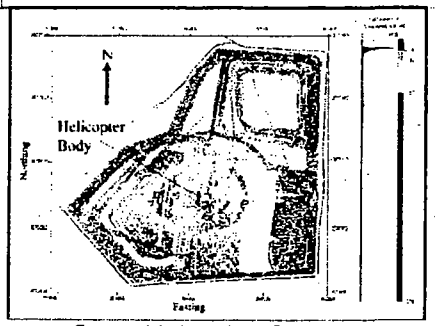
Kirtland Air Force Base



Gamma and thorium activity at TS4

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Mt. Pleasant NORM Site

Pre-Excavation Scan

Savannah River Site – Spectral Gamma Probe

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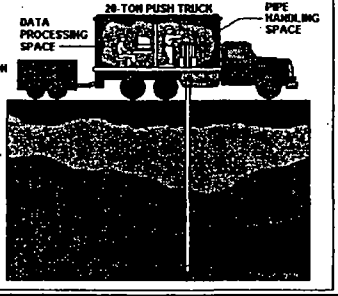
- VEHICLE
  - PUSH PROBE
  - CONFIGURATIONS
    - SENSORING
    - SAMPLING
  - GROUND CAPABILITY
  - EQUIPMENT DECONTAMINATION
  - HAZARDOUS ENVIRONMENT PROTECTION
- DATA ACQUISITION AND ANALYSIS
  - ACQUISITION - SENSORS
  - ANALYSIS
  - VISUALIZATION



Savannah River Site – Spectral Gamma Probe

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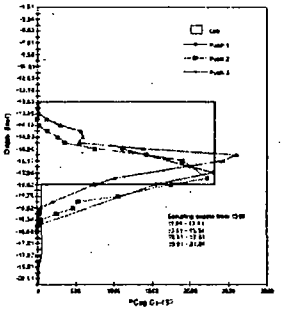

Rocky Flats

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Aerial Survey

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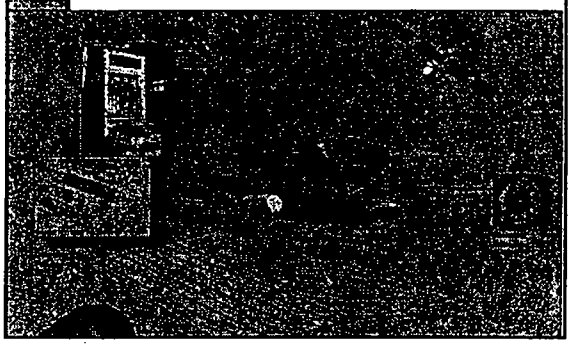

Other Radionuclide Survey Systems

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- Canberra's In Situ Object Counting System (**ISOCS**) at BNL, ANL, NTS
- Global Positioning Radiometric Scanner (**GPRS**) at INL
- Laser-Assisted Ranging and Data System and Global Positioning Environmental Radiological Surveyor System (**GPERS-II**) at Hanford
- UltraSonic Ranging and Data System (**USRADS®**) at Paducah
- Collimated NaI-based radioisotope system used by the Army Corps of Engineers at Kirkland Air Force Base

Regulatory Issues

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1. **Questions of data defendability in the CERCLA process.**
2. **Measurements are generally less precise and accurate than discrete soil-sample analysis.**
3. **Use of surrogate radionuclides at some sites could lead to greater inferential uncertainty.**
4. **Other contaminants which could not be measured with real-time methods required collection and analysis of a physical sample.**

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Benefits of Real-Time Surveys

- **Often much cheaper per measurement**
- **Allows for work and decision-making to adjust to information as it is produced**
- **Can significantly shorten the characterization, remediation and closure cycle**
- **Provides up to 100% survey of an area at a faction of the cost of traditional sampling and analysis**

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Limitations of Real-Time Surveys

These systems are :

- limited in their ability to assess contamination at depth,
- affected by environmental factors such as soil density and moisture, and
- apply a weighted averaging measurement to contaminants in the field of view.

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Conclusions:

- **Possible to rapidly measure a number of radiological contaminants in-situ.**
- **Coupling field detectors with GPS equipment allows for rapid mapping of radiological contaminants.**
- **Numerous platforms for deploying the two primary real-time detector types.**
- **Substantial cost savings.**

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Conclusions:

- **A detailed site-specific QA/QC program must be developed and maintained.**
- **Improved risk reduction both in terms of timeliness and thoroughness of characterization data.**
- **Reduce generation of secondary wastes.**

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Conclusions:

- **Reduce potential to exposure workers during collection, transportation and analysis of samples.**
- **Significant reduction in characterization uncertainty with regard to aerial extent and the delineation of hot spots.**
- **Can allow rapid incorporation of the data into the ongoing characterization or remediation project.**

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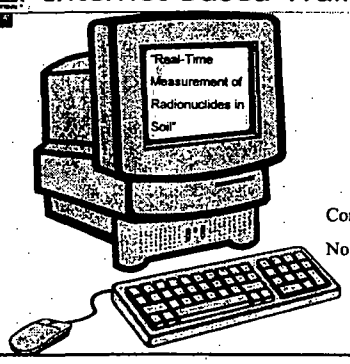
Internet-Based Training



Coming .....

November 2006